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ABSTRACT

The purposes of this study were to investigate the validity of a self-estimated persistence measure as a predictor of academic achievement and to study whether persistence interacted with instructional method. It was hypothesized that a moderate amount of persistence--neither too much nor too little--would lead to the highest achievement, forming a curvilinear relationship. It was also hypothesized that persistence would be positively related to achievement in lecture-related instruction and essentially unrelated in the individualized instructional context, creating an ordinal interaction between instructional mode and persistence. Result of the experiment supported neither hypothesis; neither the curvilinear relationship nor the ordinal interaction was found. The authors examine the reasons for their findings in detail, and bring in the complex element of motivation as a possibly relevant factor. They call for more research to examine the relationships between persistence and achievement and between persistence and instructional method. (Author/BP)

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Persistence and Achievement

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The purposes of this study were to investigate the validity of a self-estimated persistence measure as a predictor of academic achievement and to study whether persistence interacted with instructional method.

Goldman, Hudson, and Daharsh (1973) found a curvilinear relationship between self-estimated persistence and student achievement as measured by grade point average (GPA). It was suggested that students who were unable to persist would be low achievers as would those who persisted excessively. This latter group of students would spend too much time on one task and, therefore, have less time to devote to other tasks. Medium persistence, Goldman, et.al. (1973) hypothesized, should lead to higher achievement than either high or low persistence - hence, the curvilinear relationship. Chaikin (1971) also noted that, in achievement-oriented contexts, moderate persistence led to higher achievement than did either excessively long or short persistence. One purpose of this study was to replicate the finding of a curvilinear relationship between persistence and achievement.

The second purpose of this study was to examine the interaction between persistence and instructional method. It was reasoned that in individualized instructional methods in which students must attain mastery of prespecified objectives and are branched back to content they have not mastered, persistence was of less importance than in conventional lecture-recitation instruction. In in-

dividualized contexts the instructional strategy forces students to persist on tasks beyond the time they might have ordinarily. In more traditional modes of instruction, students' persistence may be more important since the instructional strategy has few provisions to induce students to spend the time necessary to attain mastery. It was expected, therefore, that persistence should be positively related to achievement in lecture-recitation instruction and essentially unrelated in the individualized instructional context, creating an ordinal interaction between instructional mode and persistence.

Persistence

The amount of time a student devotes to an instructional task, or his persistence, is a variable of obvious importance in education. Students who do not spend sufficient time learning a task will generally not learn as much as those who take the time necessary for mastery. It is, therefore, surprising that there has been relatively little applied research on persistence or its measurement.

Until recently, most research on persistence was reported by physiological psychologists involved in basic research who treated persistence as resistance to extinction. Much of the research reviewed supports the existence of a "partial reinforcement extinction effect" (Gray, 1970; Glazer, 1972) which defines persistence acquired under conditions of partial reinforcement as more resistant to extinction than that acquired on a continuous schedule.

Despite the theoretical feasibility of the extension of this notion to applied learning situations, little applied research in the area of persistence has emerged. This is especially surprising since much of the reinforcement given students in instructional situations could be interpreted as following a partial reinforcement schedule.

To date, very few studies have focused entirely on persistence or its measurement. Usually, persistence is studied as a function of some other psychological construct. Much of the available literature dealing with persistence interprets this deceptively simple phenomenon as an adjunct of locus of control (LOC) (Rotter, 1966). While a detailed description regarding the relationship between persistence and LOC is beyond the scope of this report, a brief discussion of the observed trends in this relationship should help focus the importance of persistence as a critical educational variable.

Recent research tends to confirm that while internals persist longer at tasks defined by skill requirements, externals persist longer at the same task given chance conditions (Ryckman, Rodda, and Stone, 1971; Waters, 1972). Ryckman et.al. (1971) found that males persisted longer than females inder skill conditions ehile females persisted longer given chance conditions. They also found that internal males persisted longer than external males, who persisted longer under chance conditions. These findings

led them to suggest that LOC is not a relevant variable for females in this society and that the results were attributable to role-linked behaviors considered appropriate for males and females in American culture. Although Waters (1972) examined the task persistence of younger children, he also found that male internals persisted longer under skill conditions than any other subjects in his study, while male externals persisted longer than any other group given chance conditions. His findings led him to conclude that males react differently to skill and chance parameters as a function of preexisting control expectancies and that available instruments do not adequately assess LOC for females in our society.

Prociuk and Breen (1975) examined the relationship between LOC and academic achievement by differentiating between two types of externality, congruent and defensive. Congruent externals are defined as those who are consistently other-directed in their attribution of causality. Defensive externality refers to the attribution of responsibility for reinforcement to external forces as a defense against the anxiety associated with anticipated negative evaluation of failure. It is very likely that the performance of defensive externals has contributed to the conflicting findings of previous research. They found that male and female internals achieved significantly higher levels of academic success than either male or female con-

gruent externals which is consistent with the theoretical relationship between academic performance and LOC. Their data also confirmed that defensive externals were more academically successful than congruent externals. This finding is critical considering the nonsignificant and inconclusive differences reported between internals and externals when defensive and congruent externals were not separated. It was also found that that female defensive externals were more academically successful than their male counterparts, which might help explain much of the conflicting evidence reported with respect to sex differences, LOC, and achievement.

As previously noted, defensive externals demonstrate a somewhat lower level of academic achievement than internals since they have adopted defensive externality as an anxiety-reducing measure. Consequently, the performance of defensive externals in achievement-related situations might reflect a type of conforming dependency in which "rules of the game" are followed in exchange for reinforcement from powerful others. In an academic situation, defensice externals follow the rules of the classroom in exchange for good grades from their teachers. Members of minimal power groups such as females and other minorities may be more apt to adopt defensive externality as a face-saving mechanism since it leads to reduction of achievement-related anxieties.

Such defensive behavior would affect the amount of time

students spend on learning tasks. Students who are comfortable with their ability to complete a task successfully would tend to persist appropriately to completion of the task while those who were less sure of success or convinced of failure would, respectively, try too hard or not try at all.

Despite the evidence that persistence is probably affected by the acceptance of responsibility for the outcome of one's actions and the importance of persistence in educational situations, few studies have addressed either the topics of persistence or persistence as a function of the attribution of causality, or even persistence as it affects achievement. Notable exceptions have been studies reported by Chaikin (1971) and Goldman, et.al. (1973).

Chaikin (1971) reported a study with several important implications for educators. Sixty students were randomly assigned to one of four reinforcement groups: constant success; increasing success; decreasing success (or increasing failure); and frequent failure. All were required to complete questionnaires dealing with their attitudes towards the game-like task, locus of causality, LOC, and their persistence. Results were interpreted within the context of White's theory of competency motivation and led Chaikin to conclude that "persistence is probably a curvilinear function of perceived competence, with both high and low perceived competence leading to less per-

sistence than moderate competence." (1971, p.524).

This interpretation is reasonable since people who are aware that they are either very competent or incompetent are anxious to progress to a different task although not for the same reasons, while those who are in the process of improving their performance are more likely to continue. The implications of Chaikin's (1971) report for classroom learning are relatively straightfoward: carefully arranged learning sequences which enable students to achieve increasingly frequent success at a variable rate should produce the moderate persistence necessary for optimum achievement.

Moderate persistence and optimum achievement were investigated in a report by Goldman, et.al. (1973). They also reported a curvilinear relationship between self-estimated persistence and achievement. Chaikin (1971) treated persistence as a dependent variable defined as a willingness to continue with the task, an interpretation consistent with most of the reported persistence studies. Goldman, et.al. (1973) chose to bypass manipulation of the antecedents of persistence and treated this construct as an independent variable. Persistence was assessed by a self-estimate measure developed by Goldman, et.al. and achievement by college GPA. The persistence self-estimate was individually administered to the subjects, 52 undergraduates majoring in psychology. The instrument required the students to state how long they thought they would work on each problem in relation to other students, whether the prob-

lem was solvable (all had solutions), and whether they could solve it. The 20 problems were in the areas of: mathematical reasoning; syllogistic reasoning; vocabulary; spatial reasoning; and rote search. The self-estimate score was defined as the sum of the 20 individual estimates. Data obtained supported the hypothesized curvilinear relationship between self-estimated persistence and GPA.

One major purpose of the present study was to replicate the finding of a curvilinear relationship between persistence, measured by the self-estimate developed by Goldman, et.al. and achievement measured by college GPA.

The Multimedia Tutorial Program

Learning does not usually occur in a vacuum, therefore, it is necessary to consider factors present in the educational environment which probably affect learning. Instructional method is a particularly potent factor in any learning situation, affecting task persistence and eventual achievement.

Instructional methods are either group-oriented or individualized. In the former methods, information is presented to the students as a group and it is their responsibility to assimilate the content. In individualized instructional environments, students' progress through the course is self-paced and they are given as much time as they need within the structure of the course to attain mastery.

The popularity of individualized methods may be attri-

butable to the inadequacy of traditional methods in meeting the needs of large classes and a general dissatisfaction with these traditional lecture-recitation methods (Johnson and Croft, 1975). An example of individualized instruction that has been adopted by a major urban university is Postlethwait's audiotutorial course in botany (Postlethwait, 1966).

Postlethwait's course was developed as an alternative to conventional, lecture-recitation methods where administrative and instructional convenience were given precedence over students' learning needs. The routine lecture-recitation approach was replaced by experimentally structured materials carefully fitted to the learners' needs (Dale, 1969). The College of the City of New York adapted this audiotutorial course for use by the biology department's Multimedia Tutorial Program (MMTP) in general biology.

Postlethwait's course in elementary botany developed a decade ago employs many modern communications media including 8mm film, transparencies of microscope slides, audio-and video-tapes of lectures and laboratory procedures, and printed tape scripts. Emphasis is placed upon independent study and focused on individual student needs (Dale, 1969). In addition to these features retained by the MMTP approach, other elements of the audiotutorial botany course adopted included: explicit statement of goals; carefully planned and varied learning units; focus on transfer of learning from one objective to the next; and pragmatic optimization of the sequencing of instructional

units. As in other individualized methods, students progressed at their own pace and repeated or relearned material when their unit exam scores indicated failure to attain mastery.

Students enrolled in the MMTP classes were required to attend lectures with students enrolled in the more traditionally taught lecture-recitation classes. All students were responsible for the same subject matter and related laboratory skills. Apart from the self-paced, unitized, behaviorally stated objectives of the MMTP classes, one essential difference between this method and the lecture-recitation methods was the availability of audiotutorial resources for MMTP students and the amount of instructional support extended to the MMTP students by these resources. A special center was created where MMTP students could replay video- and audio tapes of lectures and laboratories, reread tapescripts, use 8mm film loops and slides related to the unit, or review their own notes. This center was open during weekends and holidays as well as during regularly scheduled class hours and provided MMTP students with the opportunity to spend more time learning and reviewing course material, thereby regulating their persistence.

Another fundamental difference between the lecture-recitation method and MMTP was the use of learning to mastery in the MMTP classes. Mastery was defined as a grade of 72 percent on unit exams which were administered only to MMTP

students. Students were required to demonstrate mastery of one unit before progressing to the next in the instructional sequence. The test-retest feature of the MMTP classes forced students to persist at certain tasks beyond the time they might have in traditional instructional modes. This back-branching feature of the MMTP made it particularly suited to this study.

It was expected that there would be an ordinal interaction between persistence and instructional method. Persistence should be positively related to achievement, measured by score on biology posttest, in lecture-recitation classes and essentially unrelated in the MMTP classes, since the time spent on content is regulated by the instructional method rather than only be the student's persistence.

Procedure

A revised version of the self-estimated persistence instrument developed by Goldman, et.al.,whose alpha reliability was .77,was administered to 250 students in three sections of introductory biology during regularly scheduled class hours. The revised version of the persistence self-estimate differed from the original instrument in two ways. The original instrument consisted of 20 items while the revised form contained only 15 items. Both sets of items tapped the same five cognitive areas (mathematical, syllogistic, and spatial reasoning, vocabulary, and rote search). The second difference was that the original instrument re-

quired students to state: how long they thought they would work on each of the 20 problems in relation to other students; whether each problem could be solved; and whether they could solve it. The revised instrument required students only to estimate how long they thought they would work on each of the 15 problems in relation to other students.

Of the three sections assessed, two consisted of lecture-recitation and laboratory instruction, and one class was instructed by the individualized MMTP strategy.

A 33 item pretest consisting of general material from introductory level biology was administered to 368 students at the beginning of the term. The alpha reliability for this pretest was .78. At the end of the sixteenth week, all students received a 50 item posttest whose alpha reliability was.80 for 189 students. The content of the posttest, which was different from that of the pretest, was determined by all the instructors teaching the course. This posttest was composed of questions dealing with content from only one of the units of the introductory biology curriculum because the MMTP laboratories were modifications of Postlethwait's botany course.

Subjects

The initial subject pool consisted of 368 students enrolled in introductory biology at CCNY during the fall 1974 term. Missing data resulting from inadequate identification information; attrition, which is usually high in science and laboratory courses; and the absence of up-to-date GPA data

due to student transfers reduced this pool to a total of 126 students on which the analysis to validate the hypothesized curvilinear relationship between self-estimated persistence and achievement is based.

The data analysis dealing with the interaction between persistence and instructional method was based on data from 98 students, 38 in the MMTP class and 60 in the lecture-recitation sections. These students were drawn from the final pool only if complete pretese, posttest, and persistence data were available. Data from some of these students were included in the first analysis as well.

Results

A regression analysis with a second degree polynomial term failed to support the curvilinear relationship between persistence and GPA ($F < 1$, df 2/124) as reported by Goldman, et.al. (1973). There was, furthermore, no evidence for a linear relationship between persistence and GPA ($F < 1$, df 1/125). GPA data obtained from the college's computer records ranged from 0 to 4.0. The mean GPA for this group of 126 subjects was 2.46 with a standard deviation of 0.74.

The interaction between persistence and instructional method was examined by a separate regression analysis which supported main effects for persistence ($F=3.96$, df 1/97, $p < .05$) and instructional method ($F=12.28$, df 1/97, $p < .001$). The expected interaction was not found ($F < 1$, df 1/96) The results of this analysis are summarized in Table 1.

Insert Table 1 here

The results suggest that the end-of-course performance of students enrolled in the MMTP section was superior to that of students in the lecture-recitation classes. Students with higher self-estimates of persistence had higher biology posttest scores than did students with low persistence self-estimates. Table 2 summarizes the means and standard deviations obtained for students whose data were included in the second analysis.

Insert Table 2 here

There was no evidence for a curvilinear relationship between persistence and biology posttest ($F < 1$, df 2/96).

Discussion

The failure of the first analysis to support either the hypothesized curvilinear relationship between GPA and self-estimated persistence ($F < 1$, df 2/124) or a linear relationship between these two variables ($F < 1$, df 1/125) may be attributable to several factors:

1) Although both instruments were reliable, there were minor differences between the original instrument used to estimate persistence in the Goldman et.al. (1973) study and the revised form used in the present investigarion. The revised form whose alpha reliability was .77, which was supplied to us by Goldman, consisted of 15 items dealing with the same cognitive areas assessed by the original 20-item instrument. The reliability of the original instrument,

calculated by the odd-even split half method and corrected for double length using the Spearman Brown formula was .91. In the original study, students were required to respond to several questions about the 20 items while students given the revised form were only required to estimate their own persistence relative to others in the class.

2) Another factor affecting the results obtained in the present investigation was probably related to differences among the students serving as subjects in the original experiment and the present investigation. Goldman, et.al. (1973) administered the original instrument to 52 undergraduates during a course in experimental psychology. Most of these students were college juniors who had selected psychology as their field of major interest. The 126 subjects in the present investigation were mostly freshmen and sophomores who had not yet selected fields of major interest.

3) Perhaps the manner of administration most significantly affected the obtained results. Goldman, et.al.(1973) administered the self-estimate individually. It was not possible to secure the amount of time or facilities necessary for individual administration of the self-estimate during the present investigation, therefore, a group-administered format was adopted for use during regularly scheduled class time. It is possible that the self-estimates obtained in the current investigation were not as accurate or representative as those obtained in the original research because of the impersonal

tone established by group assessment in general, because the students failed to take the assessment seriously, and because the assessment was scheduled so soon after the midterm course examination.

4) Another factor which could have affected the results of the present study concerned the range of self-estimates obtained. Most of the obtained persistence self-estiamtes fell in the middle of the 0 to 75 point range ($\bar{x}_{126}$ = 45.21, sd = 10.43) which was associated with optimal achievement by Goldman, et.al. (1973) and with increasing competence by Chaikin (1971). It is possible that students who would have given extremely high or low estimates did not return to class after the midterm examination because they were threatened by anticipated negative feedback from review of the examination questions (Chaikin, 1971; Prociuk and Breen, 1975). The absence of these extreme persistence self-estimates probably biased the data by restricting the range of responses and contributed to the failure to obtain the expected curvilinear relationship.

5) A final factor affecting the obtained results was the paucity of GPA data for students in the present sample. It was regrettable that many students who provided self-estimates had not been enrolled in the college long enough to have accumulated a valid GPA (31.7 percent). This substantially reduced the number of students included in the first analysis and, thereby, affected the results.

Results of the second analysis confirmed main effects for instructional methid (F=12.28, df 1/95, $p<.001$) and persistence (F=3.96, df 1/95, $p<.05$) but failed to support the predicted interaction between them ($F<1$, df 1/94). Again, these findings are summarized in Table 1.

The largest proportion of variance was attributable to the main effect for instructional method (12.28 percent) which suggests that, in terms of the criterion measure, the MMTP method produced achievement superior to that produced by the lecture-recitation method. This finding is consistent with results noted in previous research on individualized instruction (Tobias and Ingber, 1976). Since the MMTP students had many more opportunities to review curricular content than did students in the lecture-recitation classes, it is probable that the availability of continuous, corrective feedback, backward looping, and learning-to-mastery features of the MMTP method contributed to the significant difference observed between instructional strategies.

The relatively small main effect for persistence, which accounted for less than four percent of the variance, should be interpreted more cautiously. Those students who gave the higher persistence estimates received higher scores on the posttest than did those whose estimates were lower. Perhaps these higher estimates, which were still in the range designated as "medium" and associated with optimal performance by Goldman, et.al. (1973), reflected either: 1) a tendency to be thorough and pay attention to detail rather than an in-

ability to recognize that a solution to a problem or task was beyond their abilities (Goldman, et.al.,1973) or; 2) the recognition that they were competent but that they had been taught to "check" their work (Chaikin, 1971) or; 3) the fact that students did not view an incorrect solution as ego-threatening and showed willingness to continue with a task to achieve a deferred goal (Prociuk and Breen, 1975). All of these explanations would have contributed to an appropriate, medium level of persistence and resulting optimized posttest scores. In other words, these students would have made the same effort in the course regardless of the instructional method to which they were allocated. They would have demonstrated higher achievement irrespective of methods.

The failure of the data to support the proposed ordinal interaction between persistence and instructional method is probably attributable to differences between the pretest and posttest. While the prestes ahd posttest were both reliable, alpha reliabilities were, respectively, .78 and.80, they did not cover the same course material nor did they reflect the amount of time devoted to the test content in each instructional method. The botany unit which comprised the posttest represented only one-third of the laboratory portion of the entire introductory biology course given to the MMTP students. This meant that, in effect, the instrument used as the posttest represented content presented over a relatively short period of time which focused on a relatively narrow portion

of the laboratory course. The differences were, in part, due to the fact that the MMTP course content was adapted from Postlethwait's (1966) audiotutorial course in botany. The pretest, on the other hand, was created by all instructors teaching introductory biology. The pretest, therefore, contained more general questions dealing with zoology as well as botany and also reflected assessment of information and skills acquired over the entire course rather than the narrow focus reflected by the posttest. It is quite possible that the relatively brief duration of the unit covered by the posttest affected the expected interaction. The pretest sought to determine long-term mastery of diverse content while the posttest focused on short-term mastery of one of three units of the MMTP laboratory. This lack of comprability between pre- and posttests was reflected in the relatively low correlation obtained between these instruments (r_{xy}=.43). This low correlation precluded the expected significant interaction in the present investigation.

Obtained results suggest that the underlying factor explaining the observed data may not be simply the amount of time a student persists at a learning task. It is , perhaps, more a function of motivation as suggested by Chaikin (1971) and, from a slightly different perspective, Goldman, et.al. (1973). Chaikin (1971) interpreted his findings of curvilinearity using the theories of competency motivation, achievement motivation, and the need to aviod failure. Goldman,

et.al. (1973) also noted that there was evidence for a curvilinear relationship between task persistence and motivation. Their results led them to suggest that students who want to continue with a task usually do, regardless of the origin of the desire to continue. Up to a point of "diminishing returns", students who view the task as a means to a desirable or necessary end, those who derive personal satisfaction from the task, and those who seek to avoid failure will persist.

Future research should explore the complex construct of motivation and its influence on persistence and achievement. It also remains for future research to validate the intuitively appealing, curvilinear relationship between persistence and achievement reported by Goldman, et.al. (1973) and the ordinal interaction between persistence and instructional method.

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TABLE 1

Regression Analysis: Persistence x Achievement Interaction

Variable	df	r_{xy}	Regression Coefficient	Reduction in R^2	F
Persistence (P)	1	0.136	0.21	0.036	3.96*
Method (M)	1	0.307	8.40	0.112	12.28**
PxM Interaction	1	0.361	-0.07	<0.001	<1.00

* $p < .05$

** $p < .001$

Intercept -14.16

TABLE 2

Means and Standard Deviations: Persistence x Achievement Interaction

Variable	Group	Mean	SD	N
Persistence (15 items)	Lecture-recitation	46.82	7.31	60
	MMTP	43.61	8.07	38
	Total	45.63	8.34	98
Posttest (50 items)	Lecture-recitation	23.97	4.10	60
	MMTP	28.89	6.65	38
	Total	25.89	7.83	98
Pretest (33 items)	Lecture-recitation	22.58	3.85	60
	MMTP	23.26	5.49	38
	Total	22.85	4.54	98